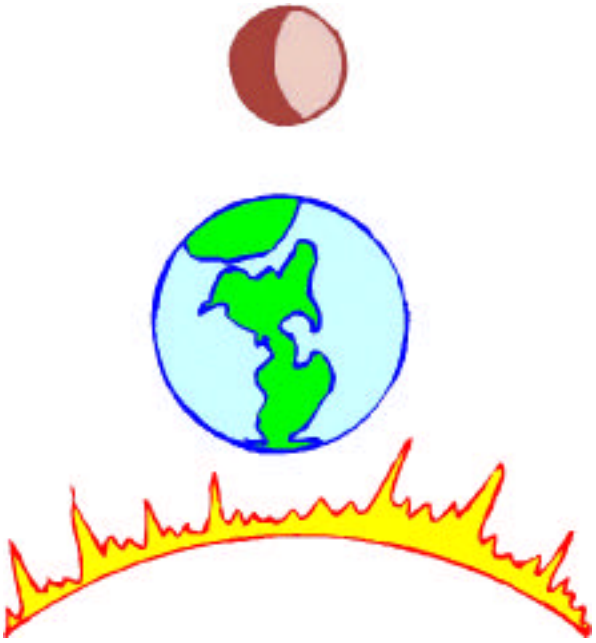
Earth, Moon, Mars Balloons

Introduction:

How big is the Moon; how far is it relative to Earth? Earth science and astronomy books depict a moon that is much closer and much larger than in reality. The example below is typical of what is found in textbooks:



The balloon activity will allow students the opportunity to construct a scale model of the Earth-Moon system, both in terms of planetary sizes and distances. In addition, students make a scale model of Mars, and discover how far one might have to travel to visit the most Earth-like planet in our Solar System. It is also a good icebreaker at the beginning of a semester, to get students to interact with each other.

National Science Education Standards:

Standard D: Earth in the Solar System

Materials (for a class of 27):

- 1 bag blue balloon (at least 9 per bag)
- 1 bag white balloons
- 1 bag red balloons
- 27 copies of Planetary Data Handout
- Rulers/measuring devices in both inches and centimeters

Step - By - Step Instructions:

1. Obtain balloons. The best are balloons with 2 1/2 inch diameter when deflated, but any balloons will work. An easy way to do this activity is to purchase balloons that are colored. The red, white, and blue balloons can be used for Mars, Moon, and Earth. (using green for Earth and yellow for the Moon are also fine).

2. Discuss the question of size of the Earth relative to the Moon. Determine what misconceptions the students may have.

3. Distribute balloons. It is best to provide one third of the class with "Earth" (i.e. blue), one third with "Moon" (i.e. white), and one third with "Mars" (i.e. red).

4. Distribute Planetary Data Handout, one per student.

5. Tell students that the Earth balloon will have a diameter of 20 cm. Have them figure out the scale (divide the Earth's actual diameter by 20 cm. Earth is about 63,800,000 times larger than 20 cm). Ask students with Earth balloons to inflate their model approximately 20 cm (obviously the balloon is not a perfect sphere, but neither is the Earth).

6. Ask students to look at the handout and calculate the size that the Moon and Mars should be, at the same scale as the Earth model. (Note the teacher's copy has the answers: the Moon should be about 5 cm, Mars about 11 cm).

7. Have students inflate the Mars and Moon balloons.

8. Ask students, at this scale, how far apart are the Earth and Moon? The diagrams seen in common textbooks might lead many of them to suggest that the Moon balloon should be held less than a meter from the Earth balloon.

9. Have students calculate the distance from Earth to the Moon at the same scale as the balloon models. The distance is about 6 meters. Have students holding the Earth models stand at one side of the room, and a partner holding a Moon model about 6 meters away.

10. Point out to students that they now have a scale model of the Earth-Moon system. Earth and its Moon are considered a double planet. The distance between the two is the distance traversed by the Apollo astronauts who went to the Moon in the 1960's and 70's. (Have students recall the film Apollo 13).

11. Compare the size of the Mars model with the Earth and Moon model. Look at the distance between Earth and the Moon.

12. Ask students how far away they think Mars will be at this scale. Have students attempt to demonstrate it in the classroom.

13. Have students calculate the distance to Mars at this scale. The answer is about 12,000 cm, which in more familiar terms is 3/4 of a mile! Have students identify a local landmark that is about 3/4 of a mile away.

14. Discuss the relative distance between Earth and Mars in the context of a human trip. How long did it take for Apollo astronauts to get to the Moon? (3 days) How long would it take for astronauts using similar technology to get to Mars? Mars Pathfinder, which launched in December 1996, arrived at Mars on July 4,1997 (7 months). Mars Global Surveyor, which launched in November 1996, arrived at Mars in September 1997 (11 months).

Extensions:

1. Ask students to make models of the Martian moons, Phobos and Deimos, at the same scale as the balloon models. They can calculate their scale diameters from the enclosed chart. It turns out that they are about the same size of a small grain of sand!

2. Have students convert all metric measurements into the English system.
1 inch = 2.54 cm, 1 mile = 1.6 km

Answers to balloon exercise:

Scale Distances		(km) / 638 =	(cm)
Earth	Moon	3.84×10^5	600 cm = 20 ft
Earth	Mars	7.80×10^7	1.2 x 105 cm = 3/4 mi

Planetary Data

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
Distance from the Sun (AU)	0.387	0.723	1	1.524	5.203	9.537	19.191	30.069	39.481
Approximate Distance from the Sun (10^3km)	57,910	108,200	149,600	227,940	778,400	1,429,725	2,870,980	4,498,250	5,906,370
Radius	2,439.7	6,051.8	6,378.14	3,397.2	71,492	60,268	25,559	24,764	1,195
Mass (Earth = 1)	0.054	0.88	1	0.149	1,136	755	52	44	0.005
Density (gm/cm^3)	5.43	5.24	5.515	3.94	1.33	0.70	1.30	1.76	1.1
Rotation Period (day length)	58.65	-243.02	0.99	1.03	0.41	0.44	-0.72	0.67	-6.39
Orbital Period (year in days)	88	225	365	687	4,333	10,760	30,685	60,190	90,800
Sideral Period (length of year in Earth years)	0.24	0.62	1	1.88	11.86	29.42	83.75	163.72	248.02
Orbital Tilt (degrees)	0	177.3	23.45	25.19	3.12	26.73	97.86	29.58	119.61
Satellites	0	0	1	2	16	18	15	8	1

Glossary

AU - astronomical unit, the distance between Earth and Sun (~1.495 * 10^8).

Rotation Period - the length of the day.

Orbital Period - the length of the year in Earth days.

Retrograde - when a celestial body rotates in the opposite direction of the Earth or clockwise.

Satellite - another name for a moon.

Sideral Period - the length of a planet's year in Earth years.

Tilt - how a far a planet is tilted sideways on its axis, measured in degrees.

Balloon Exercise

Body	Diameter (km) / 638 =	Approximate Scale (cm)
Earth	12,756	~20 cm
Moon	3,476	~5 cm
Mars	6, 794	~11 cm
Phobos	22	~0.03 cm

Scale Distances		(km) / 638 =	(cm)
Earth	Moon	3.84 x 10^5	600 cm = 20 ft
Earth	Mars	7.80 x. 10^7	1.2 x 105 cm = 3/4 mi